

NOISE REDUCTION TECHNIQUES FOR FD & ID FAN IN THERMAL POWER PLANT USING CHAMBER BASED SILENCER

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ABSTRACT

Thermal power plants are one of the noisiest processing plants. However, regular exposure to industrial noise can't be avoided which might be the reason for the neurobehavioral change, mental pressure and misery in day by day existence without demonstrating the manifestations of chronic/acute diseases. In industry, excessive noise exposure can cause both auditory and extra-auditory effects. The most important of these is hearing damage resulting from prolonged exposure to excessive noise. Another undesirable effect is speech interference or interruption of communication. Annoyance is the third undesirable effect of noise. Laboratory studies have demonstrated that clamor diminishes productivity on a few undertakings, can agitate the feeling of adjusting and can cause veins to choke, raising blood pressure and reduce the volume of the blood stream. Thus a complete noise reduction system is required to measure, monitor and reduce the noise level in a thermal power plant.

The scope of this project is to propose a chamber based silencer muffler design for draft fans, which plays an important role in thermal power plants. Draft fans (Forced Draft (FD Fan) and Induced Draft (ID Fan)) regulate the air pressure inside the boiler system.

KEYWORDS: Thermal Power Plant, Draft Fans, FD Fan & ID Fan

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1. INTRODUCTION

Power plants & Power stations are the industrial facilities for electric power generation. Since the early advent of 'steam engine' innovation, adequate accessibility of coal and reliable cheap power, individuals everywhere throughout the world intensely depend on Thermal power stations. Around 70% of energy utilized by India is delivered in Coal-fired thermal power plants. The share of hydropower plant is around 25-30% (25000MW), while the rest 3-5% is due to **Nuclear power and Wind Resources**. Generally, large power stations contain at least one generator, and a pivoting machine to change over mechanical power into electrical power. Electrical current is generated by the relative movement between the conductor and magnetic field.

SOUND is both a physical phenomenon and the sensation of hearing. By definition, Noise is unwanted sound. One person's sound, rock music, for example, can be another person's noise[1]. The trend to build more factories, to use more ground vehicles, new machines, new sound devices, new constructions and to increase aircraft, etc. has gradually created an acceptance of noise as a natural by-product of progress. Thus, noise pollution becomes another category of environmental pollution, which threatens human health and well-being. Every year, millions of people are exposed to hazardous noise. Many of them suffer impairment of hearing and become victims of increasing accidents due to noise effects. Therefore, to conduct noise assessment for any new development and to

reduce exposure to high noise levels have become a routine request.

Excessive noise can be both objectionable and hazardous; hence there is a need to reduce the noise coming out from any facility. In our case, as the noise is coming out from the industrial facilities like a thermal power plant, nuclear power plant sections, as compressor, turbine, boiler control room, Forced Draft Fan (F. D. fan), Induced Draft Fan (I. D. fan) etc, hence silencers are used for the noise reduction. The noise control can be accomplished through various-activities at the source of the sound waves, changes on the way or isolating the receiver.

The thermal power plant noise is controlled through the use of silencers and mufflers. A silencer has been the customary name for noise constriction gadgets, while a suppressor is a littler, mass-created gadget intended to decrease engine exhaust noise. Persistent advancement has been made in enhancing the performance of the silencers utilized for power plants and modern exhaust frameworks. Fumes suppressors are broadly utilized to suppress, the noise of an engine body or the noise of other prevalent sources in power plant.

Predominantly, draft fans play a vital role in thermal power plants as they regulate the gas pressure within the boiler system. Draft fans are divided into 2 sorts – Forced Draft (FD Fan) and Induced Draft (ID Fan). The first distinction between a forced draft and the Induced draft is, FD fan forces outside air into the heating plant whereas ID fan attracts flue gases from the system out into the atmosphere. Each FD fan & ID fan operate such that it balances the air system within the boiler to form the combustion method economical.

The Forced Draft Fan (FD Fan) is a basic piece of most boiler frameworks and is the component in charge of making draft within the boiler. The FD Fan gives the weight and stream required to push air, fuel, and the subsequent vent gases made from burning through the boiler, stimulus, economizer, FGR ventilation work, and stack. The I. D. fan helps flue gas to exit through the chimney. An induced draft fan is normally located at the outlet between dust collector and chimney. The fan takes hot pipe gases from the boiler through dust collector and conveys it to the chimney away from any confining influence air. FD Fans and ID Fans emanate a generous measure of noise from their intake and outlet side that regularly surpasses the permissible decibel confine in the encompassing office. To curb the excess noise, silencers are often installed on the fan to reduce the noise to a tolerable level that is within specified limits.

The rest of this paper is organized as follows. Section II presents the Background of Thermal power plant, Section III outlines Technical Review, Section IV presents System Design, Description of each module and their working is presented in Section V, complete experimental setup in Section VI, final results are presented in section VII and Section VIII presents the conclusion.

2. LITERATURE SURVEY

The historical backdrop of energy generation is long and convoluted, set apart by bunch innovative developments, calculated and specialized, from many benefactors. Numerous records start power's story at the show of electric conduction by Englishman Stephen Gray, which prompted the 1740 development of glass grating generators in Leyden, Germany. That improvement is said to have motivated by Benjamin Franklin's acclaimed tests and in addition the innovation of the battery by Italy's Alessandro Volta in 1800, Humphry Davy's first viable "circular segment light" in 1808, and in 1820, Hans Christian Oersted's exhibit the connection amongst electricity and magnetism. In 1820, in apparently the most essential commitment to present-day power systems, Michael Faraday and Joseph Henry developed a crude electric motor, and in 1831, archived that an electric current can be delivered in a wire moving close to a magnet—showing the principle

of the generator.

An invention of the primary simple dynamo is credited to Frenchman Hippolyte Pixii in 1832. Antonio Pacinotti enhanced it to give nonstop direct current power by 1860. In 1867, Werner von Siemens, Charles and S. A. Varley almost all the while contrived the "self-energizing dynamo-electric generator." Perhaps the most essential change at that point touched base in 1870, when a Belgian creator, Zenobe Gram, devised a dynamo that delivered a relentless direct current appropriate to powering motors—a disclosure that produced a burst of energy about power's capability to light and power the world.

By 1877—as the lanes of numerous urban areas over the world were being lit up by arc lighting (yet not common rooms since arc lights were still blindingly bright) Ohio-based Charles F. Brush had created and started offering the most solid dynamo configuration to that point, and a large group of forwarding masterminds was currently investigating the guarantee of vast scale power distribution. In the long run, Thomas Edison designed a less intense glowing light in 1879, and in September 1882—just a month prior to the inaugural issue of POWER magazine was published—he set up a central producing station at Pearl Street in lower Manhattan.

The primary coal-fired steam generators gave low- pressure saturated or somewhat superheated steam for steam engines driving direct current (DC) dynamos. Sir Charles Parsons, who manufactured the main steam turbine generator (with warm effectiveness of only 1.6%) in 1884, enhanced its productivity two years after the fact by presenting the principal consolidating turbine, which drove an AC generator. By the early 1900s, coal-terminated power units included yields in the 1 MW to 10 MW range, furnished with a steam generator, an economizer, evaporator, and a superheater segment. By the 1910s, the coal-terminated power plant cycle was enhanced considerably more by the introduction of turbines with steam extractions for feed water warming and steam generators outfitted with air pre-heaters—all which supported net proficiency to around 15%.

The exhibit of pulverized coal steam generators at the Oneida Street Station in Wisconsin in 1919 inconceivably enhanced coal burning, taking into consideration bigger boilers. In the 1920s, another innovative lift accompanied the coming of once-through evaporator applications and warm steam control plants, alongside the Benson steam generator, which was built in 1927. Warm steam turbines turned into the standard in the 1930s when unit appraisals took off to a 300-MW yield level. Fundamental steam temperatures reliably expanded through the 1940s, and the decade additionally introduced the main endeavors to clean flue gas with the tidy evacuation. The 1950s and 1960s were described by more specialized accomplishments to enhance effectiveness including the development of the principal once-through steam generator with supercritical fundamental steam pressure.

The mid-1980s, in the meantime, were set apart by the further improvement of emission control advances, including the introduction of specific catalytic decrease frameworks as an auxiliary measure to alleviate nitrogen oxide discharges. Segment execution additionally observed huge changes amid that period to the 21st century. Among the latest real major milestones in coal power's history is the completion of the primary expansive scale coal-fired power unit equipped with carbon catch and capacity innovation in 2014 at Boundary Dam in Saskatchewan.

3. SYSTEM ANALYSIS

3.1 There is a Different Type of Silencer in Power Plant. These are as follows

- **Engine Exhaust Silencer**

A combination of absorptive and reactive silencers used to reduce the noise produced by the expansion of steam or gas from the elevated pressure level to the atmospheric pressure level. These are used to reduce the noise produced by the exhaust gas of the fluid.[1]



Figure 3.1: Engine Exhaust Silencer

- **Compressor/ Blower Silencer**

The compressor/ Blower type of silencers are used to reduce the suction and discharge noise of the Compressor/blower when air or any other medium is sucked or discharged into and from it. These are available in different types such as Blowoff Silencer, Suction Silencer, and Discharge Silencer.



Figure 3.2: Compressor/ Blower Silencer

- **Fan Intake Silencer**

The Fan Intake silencer is utilized to diminish the suction and release noise of the fan utilized as a part of the cooling of the framework and diverse machines. It is an absorptive kind silencer and is exceptionally powerful for high-frequency noise weakening.



Figure 3.3: Fan Intake Silencer

- **Fan Exhaust Silencers**

Fan Exhaust Silencers are designed with a progression of rectangular/circular baffles comprising of mineral fleece, scrim material or wire work, utilized as a part of lessening the airborne and structural noise.



Figure 3.4: Fan Exhaust Silencers

- **Gas Turbine Exhaust Silencer**

The Gas Turbine Exhaust Silencer is utilized to decrease the exhaust noise of the fluidic gases when venting through the stack. The liquid is guided through the annular space of the acoustic packing where the overabundance noise is ingested.



Figure 3.5: Gas Turbine Exhaust Silencer

- **HVAC Silencer**

HVAC (Heating, Ventilating and Air Conditioning) mufflers are the most business type silencers. These are created using stainless steel or Aluminum compound or Carbon Steel to give it a strong and tough development that can perform at most requesting work circumstances.



Figure 3.6: HVAC Silencer

- **Duct Silencers**

Duct silencers are used to decrease the noise from the air handling system caused by the fan, passage of air through straight channels and effect of air flow through components, for example, elbows, branches, blending boxes and so forth. There are various kinds of duct silencers, these are –

- **Absorptive or Dissipative Silencers**

Absorptive or dissipative mufflers utilize sound engrossing materials to weaken sound waves. Dissipative silencers are generally utilized as a part of HVAC duct frameworks. In general dissipative mufflers are designed in a parallel baffle configuration [3].

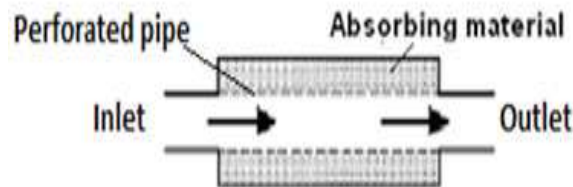


Figure 3.7: Absorptive Silencer

- **Reflective or Reactive Silencers**

The essential working of a responsive silencer is to reflect sound waves back to the source. Receptive silencers have tuned cavities or membranes and are intended to weaken low-frequency noise from machines. The reactive muffler may have incredible low-frequency performance, is non-fibrous and cleanable and has little or immaterial pressure loss.

- **Diffuser or Depressive Silencers**

Diffuser composes mufflers have punctured pepper pots to back off stream speed and keep the age of low-frequency noise and are essentially utilized for applications including spouts, control valves, fly motors and so forth.

- **Active Silencers**

Active silencers utilize mouthpieces and electronics to decide and weaken noise. Active hushing or sound cancelation frameworks utilizes locators utilized as a part of detecting the noise in an exhaust pipe and an amplifier that is utilized to reintroduce an inverted signal have been produced to decrease low-frequency noise.

3.2 Expansion Chamber

Expansion chamber comprises an inlet tube, an extension chamber, and an outlet tube. The inlet and outlet tubes might be coaxial known as a concentric extension chamber or offset known as an offset expansion chamber. Extension chambers are effective in lessening low-frequency sound, which makes them perfect for automotive applications [4].

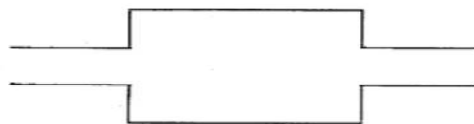


Figure 3.8: Simple Expansion Chamber

In expanded inlet and outlet expansion chamber, the inlet and outlet tubes are reached out into the extension chamber. A benefit of such a design is that part of the chamber between the extended pipe and the sidewall acts as a side branch resonator, therefore, improving the transmission loss.



Figure 3.9: Expansion Chamber with an extended Inlet and Outlet

Noise can be additionally attenuated by the option of porous material inside the expansion chamber while keeping up similar silencer dimensions. Sound waves lose energy as they go through a porous medium. The absorptive material (porous material) makes the fluctuating gas particles change over acoustic vitality to heat.

The resonating chamber style of suppressor provide noise control to a particular frequency band; however, the attenuation band is extremely narrow. This characteristic isn't extremely valuable in automotive exhaust framework where attenuation is required over all frequencies. A side branch resonator might be however utilized as a part of the expansion to a suppressor to treat a specific problem frequency.

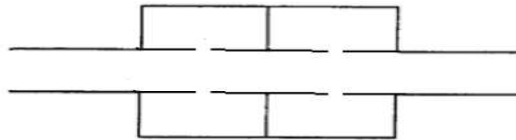


Figure 3.10: Resonating Chamber Muffler

- **Combination Muffler/Silencer**

Combination silencers are additionally broadly used to decrease engine exhaust noise. These silencers use both reactive and absorptive components to expand the noise attenuation performance over a more extensive noise range[3].

3.3 Heat Recovery Muffler/Silencer

Ordinary uses of heat recovery silencers for internal combustion engines incorporate boiling water warming, steam generation, heat transfer fluid heating.

3.4 Sound Barrier Walls

Sound Barrier Walls area unit Associate in engineered, modular panel system designed for prime reduction of outdoors noise.

The barrier wall is typically used outdoors to control industrial/mechanical noise, HVAC noise, transportation noise and other disturbing noises produced by chillers, air handling equipment, fans (FD, ID), transformers, compressors, etc. Sound barrier walls are specifically designed and **made** with environmentally **sturdy** composite construction that absorbs sound energy and blocks offensive noise.

3.4.1 Design

The acoustical science of noise barrier design is based upon blockage of sound ray travel toward a particular receptor; however, diffraction of sound must be addressed. Sound waves bend (downward) **after they pass a foothold, as** the apex of a noise barrier. Barriers that block line of sight of a **road** or **alternative supply can so** block **additional** sound. Further complicating matters is the phenomenon of refraction, the bending of sound rays in the presence of an inhomogeneous atmosphere [5].

Materials

Several different materials may be used for sound barriers. These materials can include masonry, earthwork, steel, concrete, wood, plastics, insulating wool, or composites. Walls that are manufactured from absorptive material mitigate sound in a different manner than hard surfaces. Now it is additionally possible to form noise barriers with active materials like solar photovoltaic panels to come up with electricity whereas additionally reducing traffic noise.

A wall with porous surface material and sound-dampening content material will be absorptive wherever very little or no noise is mirrored back towards the source or elsewhere. Hard surfaces like masonry or concrete are thought-about to be reflective wherever most of the noise is mirrored back towards the noise source and beyond.

A variety of materials may be used for noise wall panels, some of the more common materials are:

- Concrete
- Brick and Masonry Block
- Metals
 - Steel
 - Aluminum and
 - Stainless steel.
- Wood
- Transparent Panels
- Plastics
- Recycled Rubber
- Composites

4. SOFTWARE DESIGN

The three-dimensional geometry model of the duct silencer is created using MATLAB simulation software. The standard Power Tools are used for the simulation purpose. The program Flow Simulation software package MATLAB 2017a is being used to determine the value of the noise level at different stages of the muffler location in the channel.

To start the application we should write **power plant** in the Command Window of MATLAB, and press enter. When we start a **power plant**, the display window of the application appears, as shown in Figure 4.2.

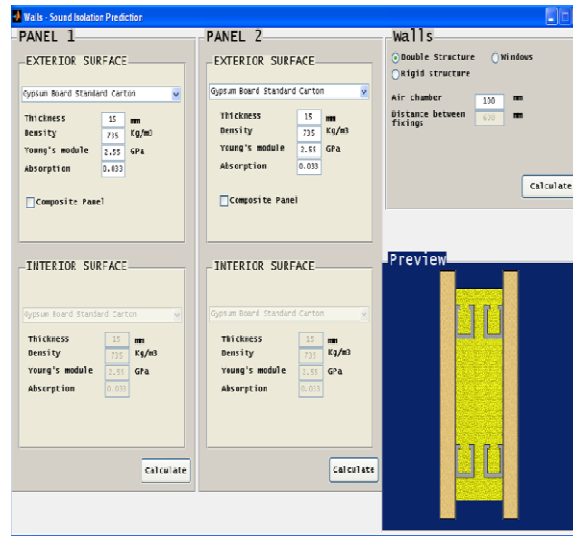


Figure 3.11: Power Plant Application Window

There are two panels PANEL 1 or PANEL 2 in the noise reduction wall as shown in the figure. Both the PANELS has two surfaces or layers (ie. exterior and interior surfaces), which can be of different materials. For each of these surfaces, we can select the type of material used for the wall from the popup menu. Different parameters of the wall like Thickness, Density, Young's module, and absorption are entered in the boxes and the transmission loss is displayed in the graph. Default PANEL 1 and PANEL 2 comes with a layer of material, by selecting **Composite panel** (clicking on composite panel checkbox), can add another layer of material (two layers of material) to each panel.

In each panel, there is a calculate button which is used to estimate the sound transmission loss of each panel either one layer or two. By pressing the calculate button on the screen it delivers a report with the results obtained as shown in the Figure below.

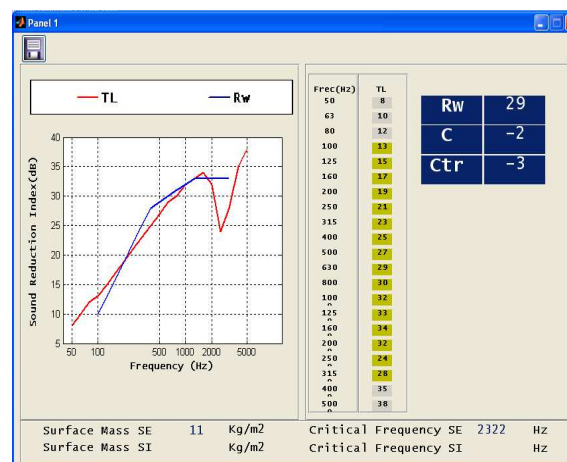


Figure 3.12: Panel 1 Window

5. HARDWARE DESIGN

The Noise Reduction chamber for FD & ID fan is a rectangular chamber and material used is stainless steel. The Size of the Noise Reduction chamber is 48*7*7 inch. Choosing the size of the chamber is depended on the duct dimensions, fan size, enough space to install and required noise reduction measures, It is clear that a larger chamber has

more noise reduction. In our research, we have tried to measure two points of the duct at downstream and upstream to compare the results and determine Transmission Loss (TL). TL is the barrier's ability to attenuate noise passing through it. In particular, TL can be defined as the difference between sound pressure level (SPL) on the source side of the barrier, and the SPL on the receiver side:

$$TL = SPL_{\text{source}} - SPL_{\text{receiver}}$$

The length of the chamber is divided into seven sections, with every section of eight inches. Each section contains plates and pipes. The Material used for plates is mild steel with a thickness of 14 gauges. While the Material used for pipe is stainless steel 204 and the thickness of the pipe is 18 gauges. Pipes used are of 5.5 cm length and 3-inch diameter, 11 cm length and 2-inch diameter, 7cm length and 1-inch diameter, 3cm and 2-inch diameter and 3 cm 1-inch diameter. Plates size are 17 * 17 cm, 17*18 cm, 17*15 cm, 17 * 13 cm, 17 * 23 cm, 17*10 cm and a net of 17 *17 cm. Complete Internal design of noise reducing chamber is shown in the figure below.



Figure 3.13: Resonating Chamber Muffler

The exhaust gases and also the sound waves enter through the middle tube. They bounce off the back wall of the muffler and are reflected through a set of pipes into the next section of the muffler, where they are reflected back through 3 tapered plates and passed to next section. In this section, wave hits the hole, part of it continues into the chamber and part of it is reflected. Now, these waves are passed through the net, here these waves are again weakened and then goes to the next section. In this section, the waves are reflected through plates and passed through a set of pipes to the next section where these waves are reflected and bounce back through a set of zigzag plates and finally exhausted through the fan.

6. RESULTS

Table 4.1: Transmission Loss using Noise Barrier

SPL _{source}	SPL _{receiver}	TL=SPL _{source} - SPL _{receiver}

7. CONCLUSIONS

We have studied many mufflers and designing methods. After studying these methods and procedures for designing a muffler, we conclude that the noise barrier chamber is more efficient than other types of mufflers. A sound-absorbing chamber is an efficient device for achieving important attenuation. Chamber performance can be increased by increasing the ratio of the cross-sectional area of the chamber to the cross-sectional area of the entrance and exit ducts and

by increasing the amount or thickness of absorbent lining. A chamber located at the fan discharge can be an effective and economical way to decrease noise entering the duct system. Sound Pressure Level (SPLs) in ducts and chambers are sensitive to duct dimensions and duct discharge types but insensitive to duct locations and room dimensions.

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